suggested: "The bacterium can live on my roots and supply me with nitrogen, and I furnish him with phosphoric acid and potash." Happily such passages, which are neither good science nor good fiction, are rare in the handy little volume.

G. H. C.

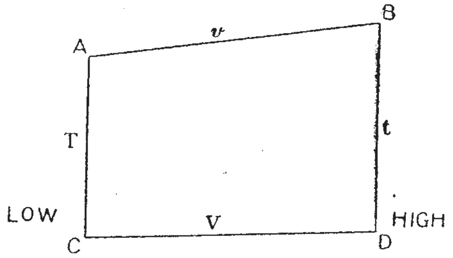
LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Horizontal Temperature Gradient and the Increase of Wind with Height.

It has been known for some time past that from heights of about 1 to 9 km. the temperature is higher in the high-pressure than in the low-pressure area, and also that in general the wind, and especially the west wind, increases with height. The following simple proof shows that these two observational facts are not independent of each other, but that, one being given, the other follows as a logical consequence.

A wind in the northern hemisphere exerts an acceleration towards its right-hand side equal to $2\omega v \sin\phi$, where ω is the earth's rotational velocity, v the velocity of the wind, and ϕ the latitude. Also, if the path of the air particles is curved, there is a further acceleration equal to v^2/r, where r is the radius of curvature, and the acceleration is away from the centre of curvature. The total acceleration to the right is $2\omega v \sin\phi \pm v^2/r$, and the sign of the term involving v^2 is positive in regions where the isobars are concave to the low pressure. However, in these latitudes the v^2 term is not as a rule important, but appears as a correction, generally positive, to the term $2\omega v \sin\phi$.



Let ABCD be a vertical section at right angles to the gradient wind, AB and CD being sections of the isobaric surfaces, and AC and BD vertical straight lines. If v be the gradient wind—*i.e.* the wind at right angles to the paper—then the tangent of the slope of AB is $2\omega v \sin\phi + v^2/r : g$, for $2\omega v \sin\phi + v^2/r$ is the horizontal acceleration and g the vertical. Similarly, the slope of CD is $2\omega V \sin\phi + V^2/r : g$. If, then, v is greater than V, BD must be greater than AC. Now the pressure difference between A and C is equal to the pressure difference between B and D, since AB and CD are isobaric lines; and since the corresponding elements in the two air columns AC and BD are of equal pressure, and the density in BD less, the temperature in BD must be higher than that in AC. That is, if v be greater than V, then t is greater than T.

Thus where the wind is increasing with height without much change in direction, anyone with his back to the wind will, if he follows an isobaric surface from left to right—that is, from cyclone to anticyclone—find an increasing temperature.

If we neglect the curvature it is easy to calculate the numerical values. An increase of 1 metre per second over a horizontal range of 100 km. in latitude 53° makes $BD - AC = 1{\cdot}28$ m.; therefore, taking AC as 1 km. and CD as 100 km., an increase of 1 m./s. per km. height makes $t - T = 0{\cdot}00128t$, or, giving to t a mean value of $250a$, $t - T = 0{\cdot}32°$. Thus an increase of 1 m./s. per km. gives in these latitudes an approximate rise of 1° C. per 300 km. along an isobaric line at right angles to the wind. This is fully in accordance with such observations as are available.

As a corollary it follows that the strongest winds have a high temperature on their right-hand side below their own level and a low temperature above, while on their left the converse holds, and it is cold above and warm below, cold and warm being used relatively to the mean for the height. Since the strongest winds are found near the upper limit of the troposphere in regions where the barometric surface gradient is steep, this again agrees with the usual distribution of temperature in cyclones and anticyclones.

The special tendency of west winds rather than east to increase with height agrees with the natural rise of temperature in the lower strata from north to south.

W. H. DINES.

Benson, February 23.

Ten Per Cent. Agar-agar Jelly.

It may be of use to put on record a method of making a jelly containing ten or more parts by weight of agar-agar to 100 parts by volume of solvent.

Agar-agar powder is apt to form lumps when mixed with water or with a mixture of water and glycerine. If this difficulty is obviated by vigorous stirring bubbles are formed. In the case of jellies of 1½ or 2 per cent. strength this does not matter, as the bubbles readily come to the surface. With thicker jellies this is not the case. These difficulties are avoided by the following procedure.

Powdered agar-agar is washed with ether, dried, and passed through a sieve. This treatment removes a fatty acid.

Twenty grams of the purified agar-agar are placed in a round-bottomed flask. The flask is provided with a cork having two holes. Through one of the holes passes a tube leading to a vacuum pump. The other tube accommodates the stem of a separating funnel. The air is exhausted, 140 c.c. of glycerine are placed in the funnel and rapidly run into the flask. The flask is shaken for a few seconds, by which time the agar-agar powder will be found to be completely and uniformly suspended in the glycerine. Sixty c.c. of water that has previously been boiled and completely cooled are now placed in the funnel, run into the flask, and mixed with its contents by a few seconds' shaking. Air is allowed to enter the flask, and the mixture is at once run out into a series of glass syringes from which the pistons have been removed and the nozzles of which are closed with rubber caps. Each syringe is filled about two-thirds full of the mixture, the pistons are replaced, and the syringes are then heated in a water-bath. The jelly is now ready for use. Caps for the nozzles may be made by boring a hole nearly, but not quite, through a rubber cork. A bent strip of tin is required for each syringe to hold the cap in place. The jelly when melted is too stiff to pour out of a test-tube. It can be readily squirted from the nozzle of the syringe.

If the proportion of glycerine is increased the jelly is weaker, but more transparent. With less glycerine

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and more water the jelly sets more firmly and cuts more easily, but is less transparent.

I have used such jelly in preparing sections of the wings of insects. The wing was first placed in an ordinary silvering solution containing Rochelle salts to which 50 per cent. of alcohol had been added. After it had thereby become blackened from the deposit of metallic silver it was washed with 50 per cent. alcohol and then placed in rectified spirit. To embed the wing after this treatment I formed a cell of plasticine on a sheet of glass. A layer of melted jelly was placed in the cell, which was then filled up with alcohol. The wing was placed in the cell. It dropped through the alcohol on to the surface of the jelly. The alcohol was at once run off by making a cut through the walls of the cell. The latter was then filled up with more of the jelly. By this procedure wings of moths and butterflies, which are not readily wetted by water, could be obtained firmly embedded, free of air-bubbles and without displacement of the scales. To the 60 c.c. of water used in making the jelly I had added 16 grams of hyposulphite of soda. Having cut the lump of jelly containing the wing into ten slices of equal thickness with a Gillette razor-blade, these slices were threaded in order on a wire, and placed all night in a half-saturated solution of tartaric acid in 70 per cent. glycerine. The acid decomposed the hypo., liberating sulphur, with the result that the jelly acquired an ivory-white colour, on which the wing-sections appeared in black. The slices were mounted in a cell containing glycerine jelly. Embedding in celluloid no doubt would be preferable for wings of smaller insects. The method here described is probably more suitable for larger insects, the wings of which would be likely to offer difficulties in an attempt to cut thin sections.

E. H. Hankin.

Agra, India.

National Service.

The wording of the enrolment form for National Service having given many the impression that volunteers are wanted only for industrial work, which some men over fifty cannot possibly undertake, I wrote to the Director of National Service for definite information, and my queries were answered as follows:—

"National volunteers are required not only for industrial work, but also for other positions of national importance."

Further: "Mr. Chamberlain wishes it to be clearly understood that brains as well as 'hands' are required, and also that no volunteer will be set to do work for which he is not fitted personally."

These very clear and authoritative replies will, perhaps, relieve the doubts of many who have been hesitating on the very reasonable ground that the work involved seemed to be beyond their capacity.

C. Welborne Piper.

THE CLASSIFICATION OF HELIUM STARS.

While it is now generally admitted that the spectroscopic differences between the different classes of stars are mainly due to differences of temperature, there are two widely divergent views as to the order of celestial evolution which may be inferred. In one of them, the evolution is supposed to proceed by a continuous decline of temperature from the white to the red stars; in the other, which has been consistently advocated by Sir Norman Lockyer during nearly thirty years, it is maintained that the progression is from stars at a low stage of temperature to the hottest stars, and from these to stars at a low temperature, so that a given star will have the same temperature twice in the course of its evolution. The classifications of Rutherfurd, Secchi, and Vogel, and the expansion of these into the Harvard system, may be interpreted in terms of the first hypothesis, though actually they may be regarded as merely empirical and independent of any such consideration. The classification of Lockyer, on the other hand, is essentially based upon the supposition that there must be stars which are getting hotter as well as stars which are cooling, in accordance with the theory of condensing masses of gas or swarms of meteorites.

If the spectrum of a star depended solely upon the surface temperature, there would evidently be no observational means of distinguishing between the two hypotheses. But Lockyer finds that when stars at any given stage of temperature are brought together by reference to the relative intensities of certain lines, selected according to the indications of laboratory experiments, they are divisible into two distinct groups. The spectra, therefore, seem to depend in part upon physical conditions other than those imposed by temperature alone. The difference is quite probably due to a difference in the degree of condensation, and Lockyer's interpretation assigns one of the groups to the ascending, and the other to the descending, branch of the temperature curve. The Harvard classification takes no account of these differences, and is accordingly along one line of temperature only.

The difference between the opposing views as to the order of celestial evolution is clearly of a very fundamental character, and it is important that the question should be attacked in as many ways as possible. The work of Prof. H. N. Russell (Nature, vol. xciii., p. 283) on the absolute magnitudes of stars has already given considerable support to the main principle of Lockyer's classification, by especially emphasising the idea that the order of celestial evolution is primarily one of increasing density, with a maximum of temperature near the middle of the sequence. As regards the helium stars, Dr. Ludendorff found in 1912 (Nature, vol. lxxxviii., p. 424) that the radial velocities showed a very decided systematic difference for the ascending and descending stars classified by Lockyer, a difference which was not so clearly shown when the velocities were referred to the Harvard sub-classes.

Since the publication of Ludendorff's results, Lockyer has supplemented his original catalogue of 470 stars by a second catalogue of 354 stars, and a third catalogue of 287 stars, photographed and classified at the Hill Observatory, Sidmouth (*Hill Obs. Bull.*, Nos. 3 and 5). The first attempt to utilise some of the additional data which have thus become available has been made by Dr. B. P. Herassimovitch in a recent communication to the Petrograd Academy of Sciences (Bull. Acad. Imp. Sci., 1916, p. 1419). In this paper the helium stars included in the first two cata-

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